

# The *Barbus perince*–*Barbus neglectus* problem and a review of certain Nilotic small *Barbus* species (Teleostei, Cypriniformes, Cyprinidae)

K. E. Banister

Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD

## Introduction

The so-called small *Barbus* of Africa are a speciose group of cyprinid fishes loosely characterized by a relatively small adult size (mostly much less than 200 mm SL) and by the presence of radiating striae on the scales. They contrast with the large African *Barbus* which generally reach a larger adult size (mostly much greater than 200 mm SL) and have parallel or converging striae on the scales. However, this is a pragmatic segregation and monophyly for either group is not implied. Although the categories 'large' and 'small' *Barbus* form convenient groupings for the majority of species, there are species and species complexes that do not fit into either category. Exceptions include the complex of North African species with European affinities, some of the large species from the Cape region of South Africa (including *Barbus andrewi* Barnard, 1937 and *Barbus serra* Peters, 1864) and a few species between these geographical extremes (including *Barbus somereni* Boulenger, 1911 from the Ruwenzori region, *Barbus litamba* Keilhack, 1908 from Lake Malawi and *Barbus huloti* Banister, 1976 from Lake Albert).

Some small *Barbus* species are immaculate whereas others have variable patterns of spots and/or stripes. Intraspecific variability of colour pattern coupled, on occasion, with similar interspecific morphometric and meristic characters have made it very difficult to distinguish between species. Such is the case with the Nilotic species *Barbus perince* Rüppell, 1837 and *Barbus neglectus* Boulenger, 1903. As more specimens, possibly referable to either of these species, have become available it has proved increasingly difficult to attribute with confidence a specimen to either species.

This paper attempts to resolve this unsatisfactory state and to re-evaluate the status of some other Nilotic small *Barbus* species. It should be noted, however, that the conclusions apply *solely* to specimens from the Nile system. The status of specimens from elsewhere is uncertain as differences between these and Nilotic specimens have been detected but insufficient non-Nilotic material was available to evaluate their significance.

## *Barbus perince* Rüppell, 1837

*Barbus perince* Rüppell, 1837 *Mus. senckenb.* 2: 12.

*Barbus neglectus* Boulenger, 1903, *Ann. Mag. nat. Hist.* (7) 12: 532.

## Comments on the synonymy

### (a) The identity of *Barbus perince* and the type specimen

Rüppell (1837) described the coloration of *Barbus perince* as (in translation) 'greenish on the back, silvery on the head and ventral regions with an inconspicuous blue streak'. There is no reference to spots on the flank and none are shown in his illustration (Fig. 1). The specimen described was stated to be no more than four inches (102 mm) long and with 31 scales in the lateral line. Despite subsequent statements, there is no evidence that Rüppell had more than one specimen. Much of his material is housed in the Senckenberg Museum, Frankfurt-am-Main, where specimen No. 851, collected at Cairo in 1834, is the only specimen dating from that time. This fish, 80 mm SL, is recognized as the holotype.

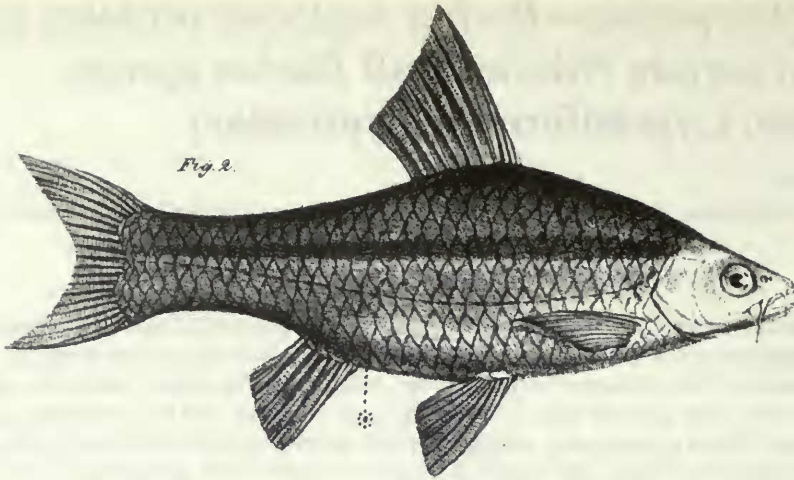


Fig. 1 *Barbus perince* from Rüppell, 1837. Original size.

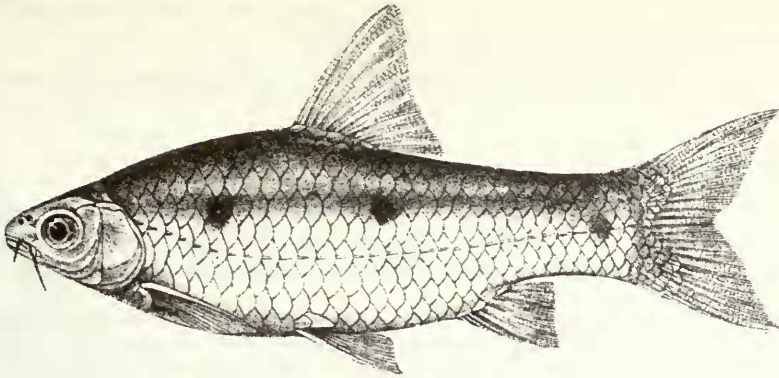
Günther (1868: 105) gave a similar description based on nine specimens but with the comment '... sometimes with a small blackish spot on the root of the caudal'. Four specimens listed by Günther as 'a-b,c-d. Adult, Nile. From Dr Rüppell's collection', are registered in the BM(NH) collections as 1850.7.29:25-26 and 1860.11.9:115-116. The first lot was purchased from Rüppell; the second was presented by him. There is no indication in either the register or in Günther (1868) that they had type status. No other specimens listed by Günther were collected by, or associated with Rüppell. Günther (1869: 262) again gave a description of *Barbus perince* which scarcely differed from his previous one.

Boulenger (1907) gave an expanded description based on more specimens, many collected by Mr Loat between 1899 and 1902. He reported 'some specimens, and such are Rüppell's types from Cairo, are uniform silvery, with the back pale sea-green, the fins white and transparent. Others, and these seem to be by far the more frequent, have three more or less distinct round blackish spots on the middle of the side. . . Such specimens from the Damietta branch of the Nile, are thus described by Mr Loat:— "Silvery white, the fins colourless, or with a faint tinge of lemon on the dorsal and caudal, the back a dull brownish yellow, bordered below by a line of shot reddish gold, the three blackish spots are not visible when the fish is first taken out of the water, but appear a short time afterwards"'. . . The specimen illustrated (Boulenger, 1907, plate 47, fig. 2) (Fig. 2) has three conspicuous spots. At the end of this description is '4, Nile at Cairo—Rüppell 1833 (Types)'. There is no reason why Boulenger should have considered these specimens to be types or to have been collected in 1833. Rüppell's letters in the BM(NH) archives show that the specimens accessioned in 1850 were caught by Rüppell in 1849 and sent to London directly from Egypt. The other alleged types were selected from Rüppell's private collection by Günther when he visited Frankfurt in 1860. None of these four specimens can therefore be considered to have type status.

Boulenger used his 1907 illustration again in the *Catalogue of the freshwater fishes of Africa* (Boulenger, 1911: 170). The accompanying description placed far more emphasis on the diagnostic value of the three 'more or less distinct round blackish spots on each side of the body, the first before, the second behind vertical of base of dorsal, the third at root of caudal'. It is this description that has been used by subsequent workers to determine a specimen as *Barbus perince*.

#### (b) Description of the holotype of *Barbus perince*

The overall body shape is well represented by Rüppell's original figure (reproduced here—Fig. 1) and that newly drawn from the holotype (Fig. 3). The fish is 80 mm SL and its measurements (expressed as a percentage of the SL) are: body depth = 32.5; head length = 23.8; eye diameter = 6.6;



2.

Fig. 2 *Barbus perince* from Boulenger's 'Fishes of the Nile' 1907 plate 47, Fig. 2. Original size.

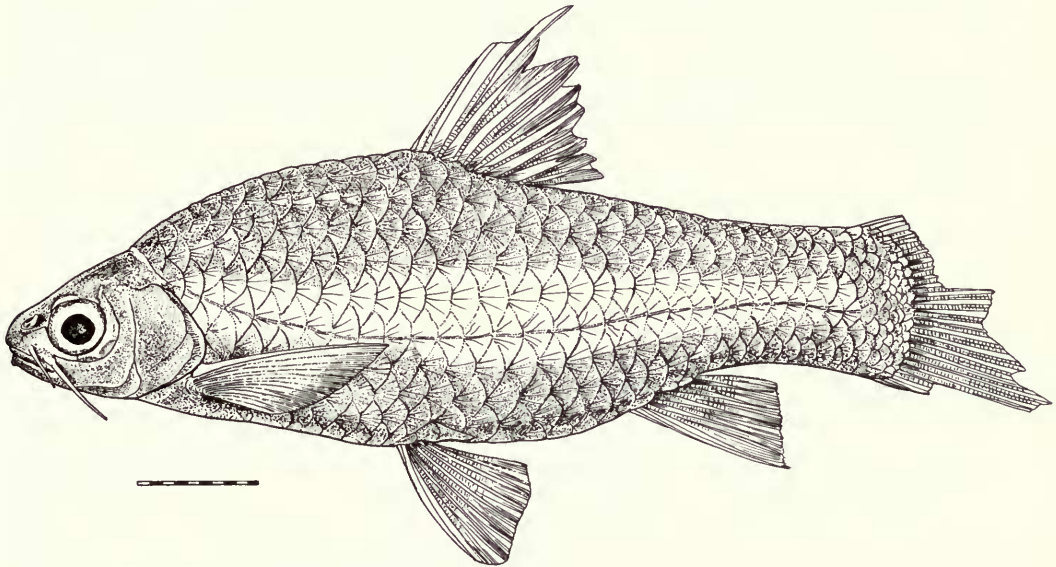


Fig. 3 *Barbus perince*, the holotype, 80 mm SL. ZMB 851. Drawn by Gordon Howes.

caudal peduncle length = 20.0; caudal peduncle depth = 16.2; pectoral fin length = 21.2; anterior barbel length = 3.7; posterior barbel length = 6.2. The origin of the dorsal fin is slightly in advance of the vertical from the pelvic fin origin. The dorsal fin has three unbranched and seven branched rays; the anal fin has three unbranched and five branched rays.

**SQUAMATION.** There are 29 scales in the lateral line (Rüppel's count of 31 lateral line scales included those extending onto the base of the caudal fin). The lateral line runs along the lower half of the caudal peduncle. There are  $5\frac{1}{2}$  scale rows from the dorsal mid-line (immediately in front of the dorsal fin) to the lateral line and  $4\frac{1}{2}$  from there to the ventral mid-line. Around the least circumference of the caudal peduncle there are 14 scales. The scales have few radiating striae and some scales, especially on the lower, posterior part of the body have reticulate foci. Although the foci resemble those of replacement scales (Neave, 1940) they occur too frequently on the individual (and in all specimens examined) for these scales to be replacement scales.

**GILL RAKERS.** There are seven widely and evenly spaced simple gill rakers on the first ceratobranchial, their shape exemplified by those in Fig. 16B.

**COLORATION.** The body colour is entirely pale and silvery. No dark spots are present.

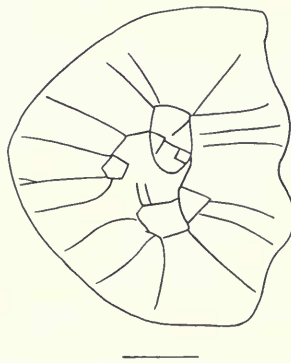
**(c) Other specimens previously given type status**

There is no doubt that the four specimens Boulenger claimed to be types are conspecific with the holotype. These (BMNH 1850.7.29: 25–26 and 1860.11.9: 115–116, SL 65–74 mm) have the following characteristics. The proportional measurements are expressed as a percentage of the SL.

**MORPHOMETRIC FEATURES.** Body depth  $\bar{x}$  = 34.7, range = 32.3–37.3; head length  $\bar{x}$  = 23.0, range = 21.5–24.3; eye diameter  $\bar{x}$  = 6.2, range = 5.9–6.7; caudal peduncle length  $\bar{x}$  = 20.6, range = 20.3–21.5; caudal peduncle depth  $\bar{x}$  = 15.6, range = 13.5–16.2; pectoral fin length  $\bar{x}$  = 20.6, range = 19.4–20.9; anterior barbel length  $\bar{x}$  = 3.2, range = 2.9–3.9; posterior barbel length  $\bar{x}$  = 6.2, range = 5.4–7.6.

**FINS.** In the dorsal fin there are three (f3) or four (f1) unbranched rays and seven (f4) branched rays. The dorsal fin origin is slightly in advance of the vertical from the pelvic fin origin. The anal fin has three unbranched and five (f4) branched rays as do most small *Barbus* species.

**SQUAMATION.** There are 26 (f2), 27 (f1) or 28 (f1) scales in the lateral line,  $5\frac{1}{2}$  scale rows from the dorsal mid-line (immediately in front of the dorsal fin) to the lateral line and  $4\frac{1}{2}$  (f4) from that point to the ventral mid-line. Between the lateral line and the pelvic fin base there are  $2\frac{1}{2}$  (f4) scales. Fourteen scales encircle the least circumference of the caudal peduncle. The scale striations and some foci are like those of the holotype (Fig. 4). The lateral line runs along the lower half of the caudal peduncle.



**Fig. 4** A scale from one of the BM(NH) 'type' specimens of *Barbus perince*. SL 65 mm SL. Scale bar = 1 mm.

**GILL RAKERS.** There are 7 (f1) or 8 (f3) widely spaced gill rakers.

**PHARYNGEAL BONES AND TEETH.** The pharyngeal teeth number 2.3.5–5.3.2 and the rows are parallel (Fig. 5).

**COLORATION.** The fishes are entirely pale and silvery. No spots are present.

The species that has most often been confused with *Barbus perince* is *Barbus neglectus* which is discussed below.

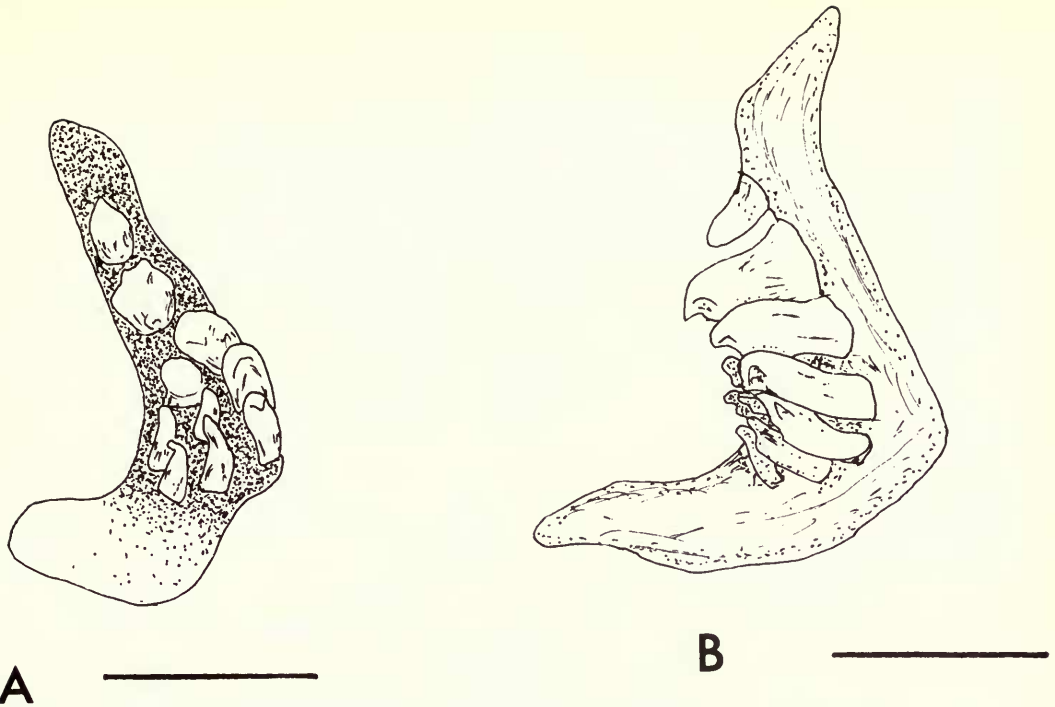


Fig. 5 A. Left pharyngeal bone of the 65 mm SL 'type' specimen of *Barbus perince* to show the alignment of the tooth rows. Scale bar = 2 mm. B. The same pharyngeal bone laid on its edentulous surface. Scale bar = 2 mm.

(d) *Barbus neglectus* Boulenger, 1903

The original description was short, unillustrated and based on an unknown number of specimens. Specimens subsequently designated as syntypes by Boulenger (1911) were not registered until 1907 (1907.12.2: 1303–22 from Luxor; 1907.12.2: 1323–24 from Luxor to Assuam; 1907.12.2: 1327 from Ghat-el-Narua; all were collected by Loat). Neither the entries in the register nor the original labels on the bottles indicate that these are type specimens. Specimens registered before these (1905.10.26: 12–15 and 16–17) and collected by Flower from respectively, Rosaires and Wadi Medina, were never accorded type status. *Barbus neglectus* was illustrated and an enlarged description given by Boulenger (1907), (Fig. 6 here).

The sample from Luxor (1907.12.2: 1303–22) allegedly with twenty specimens actually contains 29, of which 26 match Boulenger's (1907) description and can be considered to be *Barbus neglectus*. The three other specimens are not *Barbus neglectus*, but their condition precludes their identification. (It should be noted that under-registering was a common practice at that time.) Two of the 26 *Barbus neglectus* specimens are of approximately the same total length (54 mm and 48 mm SL) that was quoted in the original description. One of these which matches the first illustration has been isolated, assigned the number 1907.12.2: 1303, and is here designated as lectotype.

For ease of comparison with the holotype of *Barbus perince*, the lectotype (in parentheses) and the five largest paralectotypes are described; SL 42–48 mm (48). Measurements are expressed as a percentage of the SL. The corresponding data for non-type material are on p. 118.

**MORPHOMETRIC FEATURES.** Body depth  $\bar{x}$  = 29.1, range = 27.8–30.2 (30.2); head length  $\bar{x}$  = 23.6, range = 22.7–24.4 (24.0); eye diameter  $\bar{x}$  = 7.8, range = 7.1–8.3 (8.3); caudal peduncle length  $\bar{x}$  = 20.4, range = 19.6–21.3 (19.8); caudal peduncle depth  $\bar{x}$  = 14.6, range = 14.0–16.0 (15.6); pectoral fin length  $\bar{x}$  = 19.5, range = 17.8–22.2 (18.7); anterior barbel length  $\bar{x}$  = 3.7, range = 2.3–5.2 (3.1); posterior barbel length  $\bar{x}$  = 6.0, range = 3.1–6.6 (5.2).

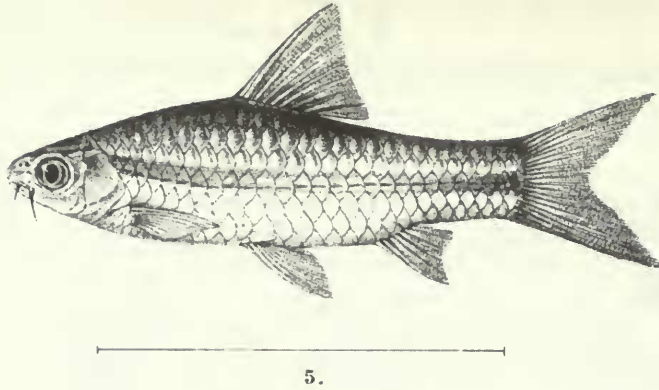


Fig. 6 *Barbus neglectus* from Boulenger's 'Fishes of the Nile' 1907 plate 47 Fig. 5. Original size.

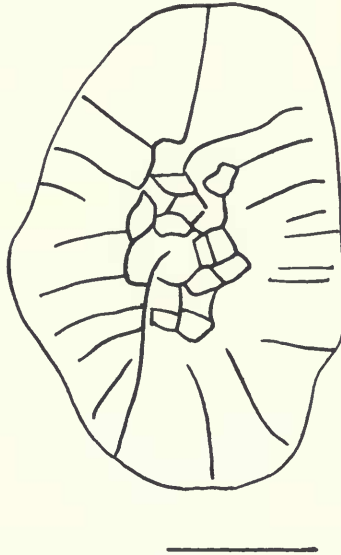


Fig. 7 A scale of the lectotype of *Barbus neglectus*. Scale bar = 1 mm.

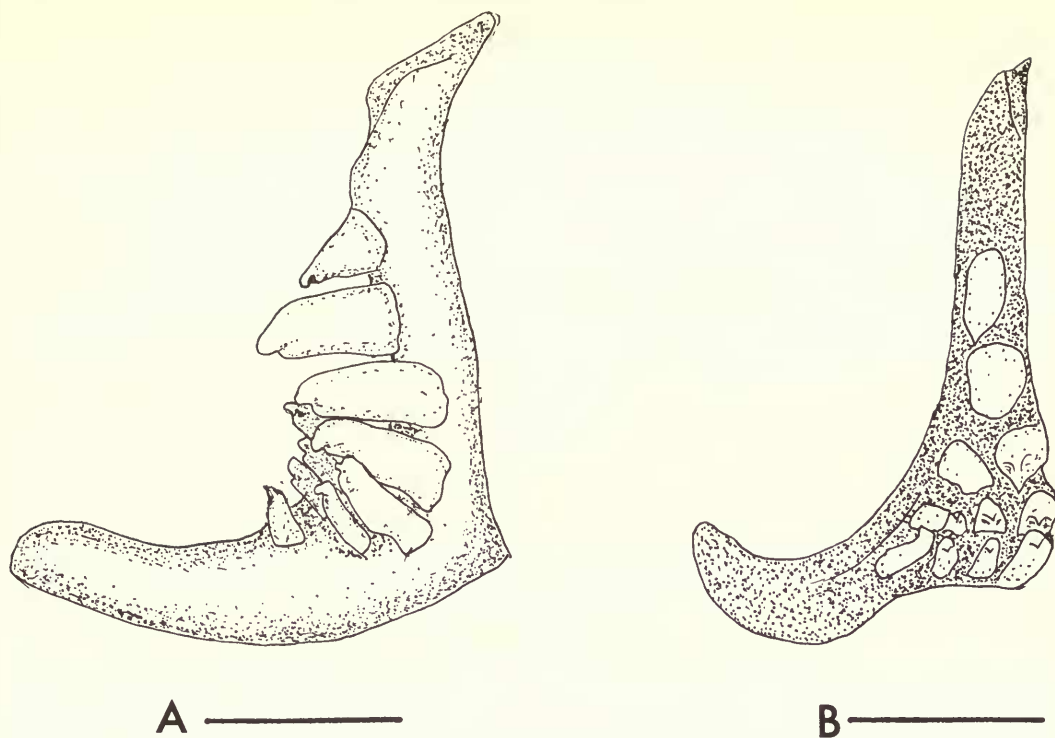
The body shape is shown in Fig. 6.

**FINS.** The dorsal fin has three unbranched and 7 (f1) or 8 (f5) branched rays. Its origin is slightly in advance of the vertical from the pelvic fin insertion. The anal fin has three unbranched and five branched rays.

**SQUAMATION.** Lateral line with 24 (f2), 25 (f2), 26 (f1) or 27 (f1) scales;  $3\frac{1}{2}$  (f5) or  $4\frac{1}{2}$  (f1) ( $3\frac{1}{2}$ ) scale rows from the dorsal mid-line (in front of the dorsal fin origin) to the lateral line and  $3\frac{1}{2}$  (f5) or  $4\frac{1}{2}$  (f1) ( $3\frac{1}{2}$ ) from the lateral line to the ventral mid-line. Between the lateral line and the pelvic fin base there are 2 (f5) or  $2\frac{1}{2}$  (f1) (2) scale rows. Twelve scales (f6) encircle the least circumference of the caudal peduncle.

The scales (Fig. 7) bear few radiating striae and many have a reticulate focus, especially those on the lower, posterior part of the body.

**GILL RAKERS.** There are 8 (f3) or 9 (f3) short, broad, widely spaced gill rakers on the first ceratobranchial.



**Fig. 8** A. Left pharyngeal bone of the largest paralectotype of *Barbus neglectus*, lying on its edentulous surface. Scale bar = 1 mm. B. The same pharyngeal bone positioned to show the alignment of the tooth rows. Scale bar = 1 mm.

**PHARYNGEAL BONES AND TEETH.** The left pharyngeal bone of the large paralectotype is atypical in possessing 4 rows of teeth (1.2.3.5) (Figs 8A & 8B). In all other respects, the teeth and the rows are the same as those of *Barbus perince* shown in Figs 5A & 5B. In three other specimens examined, the single tooth of the fourth row is absent.

**COLORATION.** The body is silvery brown and devoid of spots.

### Discussion

In Boulenger (1911) the main diagnostic differences between *Barbus perince* and *Barbus neglectus* are that the body of the former is deeper and that larger fishes (usually identified as *Barbus perince* in museum collections) tend to have 14 circumpeduncular scales compared with 12 in smaller specimens (which were referred to *Barbus neglectus*). This increase in scale number with growth will be discussed in a separate publication.

The similar meristic and morphometric data (allowing for allometry e.g. the deeper body in larger specimens), and the frequent presence of reticulate foci on the scales, indicate that *Barbus neglectus* is conspecific with *Barbus perince*. Indeed, if smaller specimens (previously identified as *Barbus neglectus* in the BM(NH) collections) are arranged in size series with larger specimens (i.e. *Barbus perince*) a morphometric continuum is established and the differences recorded by Boulenger (1911) are no longer significant.

*Barbus perince* is normally a silvery fish; only a small proportion (32 out of 145 specimens) have any spots. When present, the spots are faint but their position is important in distinguishing spotted *Barbus perince* specimens from the species described below. The first spot, about the size of a scale, lies over the overlap of the sixth and seventh scales of the row above the lateral line and extends onto the scale dorsal to this overlap. The second spot is in a similar position eight scales

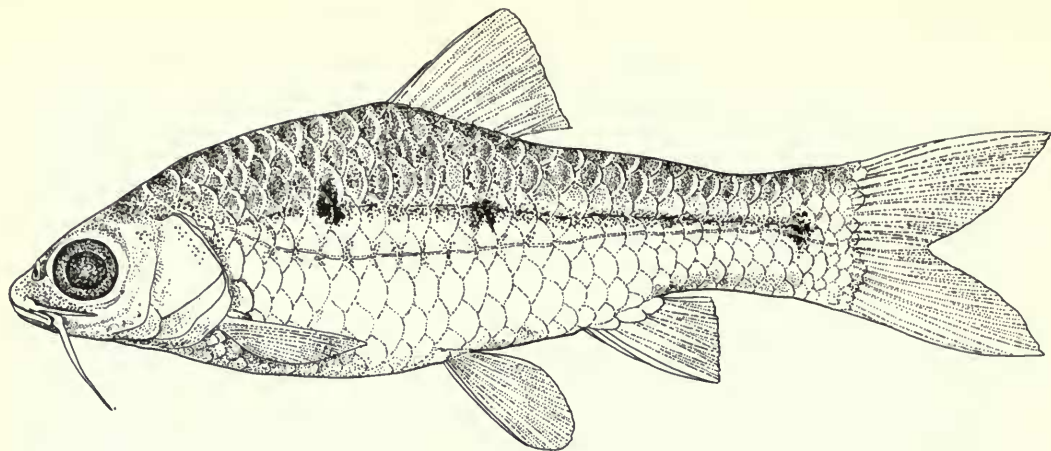


Fig. 9 An example of the heavily spotted species formerly confused with *Barbus perince*. Drawn by Gordon Howes. Scale bar = 5 mm.

beyond the first on the same row and *behind* the vertical from the base of the last dorsal fin ray. The third spot lies mostly on the lateral line scale immediately behind the point of caudal flexure. In all the specimens with spots, that on the caudal peduncle is always present; in four specimens it is the only one present. Fifteen specimens have just the first and third spots, and thirteen have all three spots.

Once it is accepted that only about 25% of the specimens of *Barbus perince* have spots, the question of the identity of the other spotted specimens previously identified in museum collections as *Barbus perince* and *Barbus neglectus* is raised. It is argued below that these spotted fishes (Fig. 9) may be *Barbus stigmatopygus*, hitherto only known as a very small fish.

### *Barbus stigmatopygus* Boulenger, 1903

*Barbus stigmatopygus* Boulenger, 1903 *Ann. Mag. nat. Hist.* (7) 12: 533.

*Barbus miolepis* Boulenger, 1903 *Ann. Mag. nat. Hist.* (7) 12: 533. (*nec* Boulenger, 1902 *Annls Mus. r. Congo Belge* 2: 32).

*Barbus wernerii* Boulenger, 1905 *Proc. zool. Soc. Long.* 1: 63.

*Barbus alberti* Poll. 1939 *Explor. Parc natn. Albert Miss G. F. de Witte* 24: 28.

### Notes on the synonymy

#### (a) *Barbus stigmatopygus*

From the time of Boulenger's brief original description (1903) and his enlarged redescription (1907) *Barbus stigmatopygus* has been diagnosed as a species reaching a very small adult size (24 mm total length), without an enlarged unbranched ray in the dorsal fin, without barbels and with only the anterior scales of the lateral line having pores (Boulenger, 1911; Sandon, 1950). However, Boulenger was in error regarding the barbels. Of the eight syntypes [BM(NH) 1907.12.2: 1255–60], SL 20 (f2), 19, 16, 15 (f2) and 14 (f2) mm, the three largest have a pair of posterior barbels respectively 1.0 (f2) and 0.6 mm long. There is no sign of the anterior barbels, but the specimens are in poor condition and may at some time have been partially dried.

Morphometric and meristic characters of the six largest syntypes are given below. The other two syntypes are too soft and damaged to provide any useful data. All proportional measurements are expressed as a percentage of the standard length.



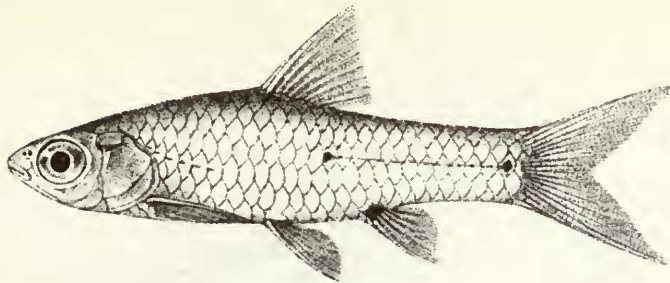


Fig. 10 *Barbus stigmatopygus*, a syntype from Boulenger's 'Fishes of the Nile' 1907 plate 47 Fig. 8. Original size.

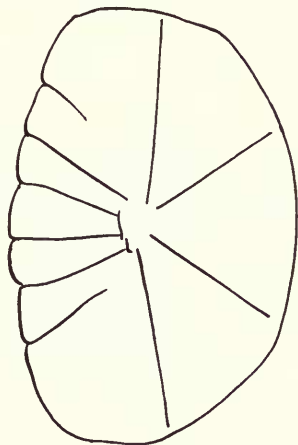


Fig. 11 A scale from a syntype of *Barbus stigmatopygus*. Scale bar = 0.5 mm.

**MORPHOMETRIC FEATURES.** Body depth  $\bar{x}$  = 27.0, range 25.0–28.6; head length  $\bar{x}$  = 26.7, range = 24.7–28.4; eye diameter ( $n = 5$ )  $\bar{x}$  = 9.3, range = 9.0–10.0; pectoral fin length  $\bar{x}$  = 19.8, range = 18.0–21.0; caudal peduncle length  $\bar{x}$  = 21.6, range = 20.5–24.0; caudal peduncle depth  $\bar{x}$  = 13.5, range = 11.9–15.0; posterior barbel length ( $n = 3$ )  $\bar{x}$  = 4.4, range = 3.2–5.0.

**FINS.** The dorsal fin has 3 unbranched and 7 (f1) or 8 (f5) branched rays. The last unbranched ray is neither stiffened nor enlarged. The anal fin has three unbranched and five branched rays in all specimens.

**SQUAMATION.** In the four syntypes from which lateral scale counts were obtainable there are 23 (f2) or 24 (f2) scales in the line of which the first 5 (f2) or 6 (f2) are pored. Around the least circumference of the caudal peduncle there are 10 (f4), 11 (f1) or 12 (f1) scales. The scale shape and distribution of the striae are shown in Fig. 11.

**GILL RAKERS.** Of particular note are the low number and the arrangement of the gill rakers (Fig. 12). There are only 2 (f2) conspicuous gill rakers situated on the dorsal part of the first ceratobranchial close to the angle with the epibranchial. The ventral half of the bone is covered with an irregularly papillate tissue (see. p. 126).

**PHARYNGEAL BONES AND TEETH.** The pharyngeal bone has recurved, hooked pharyngeal teeth arranged in three rows numbering 2.3.5–5.3.2. The two teeth of the outer row are not parallel with the middle row (see p. 118).

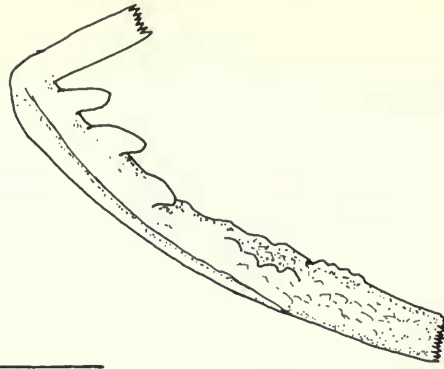
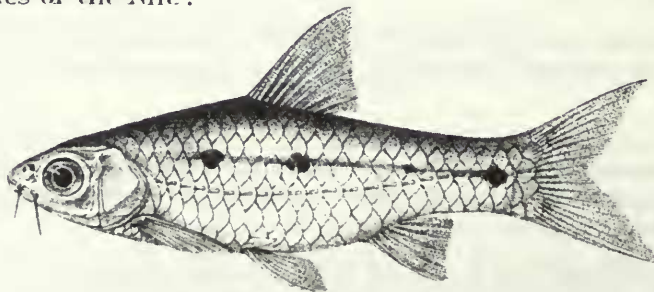


Fig. 12 The gill rakers on the first ceratobranchial of a syntype of *Barbus stigmatopygus*. Scale bar = 0.5 mm.



Fig. 13 A pharyngeal bone from a syntype of *Barbus stigmatopygus* Scale bar = 0.5 mm.

Fishes of the Nile.



6.

Fig. 14 One of the syntypes of *Barbus wernerii* from Boulenger's 'Fishes of the Nile' 1907 plate 47 Fig. 6. Original size.

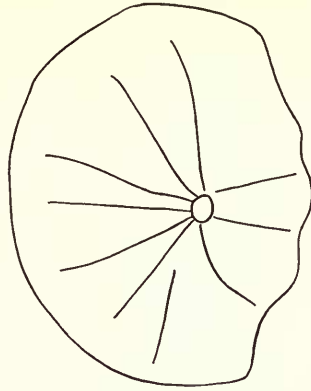


Fig. 15 A scale from the headless syntype of *Barbus wernerii*. Scale bar = 1 mm.

**COLORATION.** Although the syntypes have the relative uniformity of colour caused by long storage in alcohol and have lost many anterior scales, a pigmentation pattern can be discerned. There are three dark spots, each about the size of a scale, on the flanks. The first spot lies in the same relative position in all specimens but in only one can it be confirmed as at the level of the overlap of the seventh and eighth scales in the row above the lateral line. The second spot is on the 6th–7th (f2) or the 7th–8th (f1) scale behind the first and lies on or in front of the vertical from the last dorsal fin ray. The third spot is situated on the caudal peduncle at the caudal flexure. The two posterior flank spots may be joined by a thin dark line. There is also a small dark spot at the base of the anterior anal fin rays.

#### (b) *Barbus wernerii*

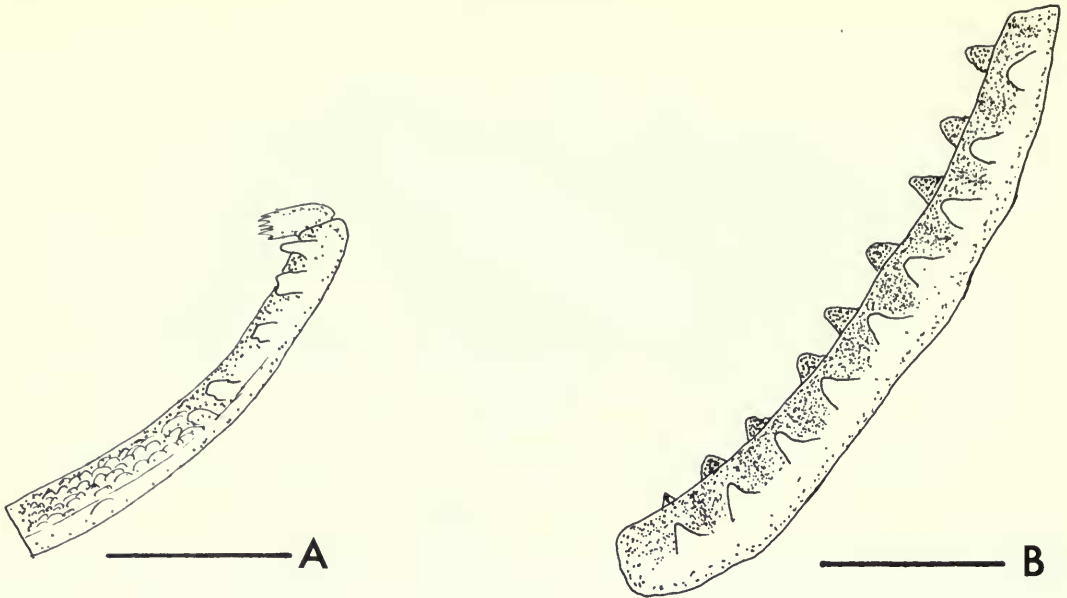
*Barbus wernerii* is a replacement name for *Barbus miolepis* Boulenger, 1903 preoccupied by *Barbus miolepis* Boulenger, 1902 a Congo species with a serrated and spinous last unbranched dorsal fin ray. Boulenger (1905: 63) realized his error in proposing a homonym and used the name '*wernerii*' for the Nilotic '*miolepis*' but confusingly dated that name as 1893. I have been unable to find any paper in 1893 dealing with Nilotic fishes. Indeed in Boulenger's own annotated bibliography (Boulenger, 1921) the Congo *miolepis* is dated as 1902 and no relevant article is listed for 1893. One must therefore assume that the 1893 attribution was a *lapsus*. It should be noted that the figure of the 'true' *miolepis* in Boulenger (1911 fig. 117) has been transposed with fig. 131 where it is captioned as *Barbus humeralis*.

In the original description of *Barbus miolepis* Boulenger (1903) did not state how many specimens he examined. In 1907 he listed the types as coming from four localities: these are 1907.12.2: 1328–32, Lake No, White Nile; 1907.12.2: 1333, Fashoda, White Nile; 1907.12.2: 1934, Kaka, White Nile and 1907.12.2: 1335 Gondokoro, Bahr-el-Gebel. Most are in poor condition and only three specimens (i.e. 1907.12.2: 1334 and two in 1907.12.2: 1328–32) are sufficiently well-preserved to provide meristic and morphometric data.

The morphometric characteristics of the three well-preserved syntypes, fishes of 26, 29 and 30 mm SL are given below. All measurements are expressed as a percentage of the standard length.

**MORPHOMETRIC CHARACTERISTICS.** The body shape is shown in Fig. 16.

Body depth  $\bar{x}$  = 28.7, range = 26.9–31.0; head length  $\bar{x}$  = 27.0, range = 26.6–27.6; eye diameter  $\bar{x}$  = 9.1, range = 8.0–9.6; caudal peduncle length  $\bar{x}$  = 18.9, range = 18.4–19.6; caudal peduncle depth  $\bar{x}$  = 14.8, range = 13.8–15.5; pectoral fin length  $\bar{x}$  = 20.0, range = 18.3–21.1; anterior barbel length  $\bar{x}$  = 8.1, range = 7.7–8.3; posterior barbel length  $\bar{x}$  = 10.1, range = 9.2–11.7. The barbels are conspicuously long, the anterior, when entire, reaching to below the centre of the eye, and the posterior almost to the angle of the preoperculum.



**Fig. 16** A. The first ceratobranchial of the headless syntype of *Barbus wernerii*. Scale bar = 1 mm. B. For comparison, the first ceratobranchial of *Barbus perince* to show the normal condition of the gill rakers in small *Barbus* species. Scale bar = 1 mm.

**FINS.** The dorsal fin has 3 (f6) unbranched and 7 (f1) or 8 (f5) branched rays. The anal fin has 3 unbranched and 5 branched rays (f6).

**SQUAMATION.** The lateral line series has 24 (f2), 25 (f2) or 26 (f2) scales. There are  $4\frac{1}{2}$  (f6) scale rows from the dorsal mid-line to the lateral line and  $3\frac{1}{2}$  (f1) or  $4\frac{1}{2}$  (f5) from the lateral line to the ventral mid-line. Twelve scales encircle the least circumference of the caudal peduncle (f6). The scales have few radiating striae.

**GILL RAKERS.** The first ceratobranchial has the same arrangement of gill rakers seen in the syntypes of *Barbus stigmatopygus* (Fig. 16A). There are two large and one small gill rakers dorsally. The ventral part of the bone is covered with irregularly papillate tissue. Very small, widely spaced ridges, of unknown homology are present below this tissue. The ventral ridges were not detected in the very small syntypes of *Barbus stigmatopygus*. This configuration of gill rakers is contrasted with the modal condition in small *Barbus* in Fig. 16B.

**PHARYNGEAL BONES AND TEETH.** The pharyngeal bones were removed from a badly damaged syntype of about 30 mm SL (ex 1907.12.2: 1328–32). They have a 2.3.5–5.3.2 tooth arrangement (Fig. 17). The teeth of the outer row are not parallel with the middle row. This can be seen from the position of the crowns but could not be illustrated as attempts to clear the residual tissue from between the teeth destroyed the bone.

**COLORATION.** Seven syntypes have markings consisting of 5 (f2), 4 (f3) or 3 (f2) dark spots. The first spot is very small and on the fourth scale of the row above the lateral line. The second spot is larger, about the size of a scale and is at the overlap of the sixth and seventh (f1) or seventh and eighth (f6) scale of the same row and the scale dorsally between them. Like the second spot, the third is at the level of the horizontal septum and lies on, or before, the vertical from the base of the last dorsal fin ray. The fourth spot is very small and is situated five scales caudad to the third spot in the same scale row. The fifth spot is visible between the second and third pored-scales from the posterior end of the lateral line. The second, third and fifth spots present in all these specimens, correspond in position to those of *Barbus stigmatopygus*.

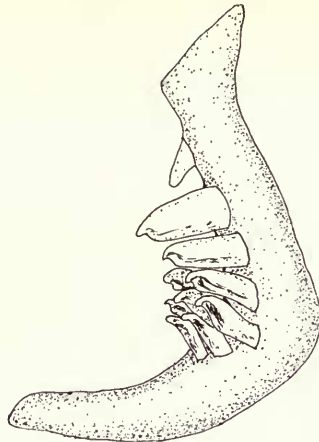


Fig. 17 A reconstruction of the left pharyngeal bone of the headless syntype of *Barbus wernerii*. The bone was accidentally destroyed in the later stages of preparation. Scale bar = 0.5 mm.

In the smaller syntypes there is some weak pigmentation at the base of the anal fin. This is missing in the larger specimens but a thin, weak line of pigment is present between the posterior spots.

The body colour is brown, darker dorsally. The fins are colourless.

### Discussion

The paucity of gill rakers and the presence of papillate tissue on the ventral part of the first ceratobranchial (p. 126), the disposition of the pharyngeal teeth (p. 127) and the position of the spots on the flank are characters sufficiently diagnostic to consider *Barbus wernerii* to be conspecific with *Barbus stigmatopygus*.

#### (c) *Barbus alberti*

*Barbus alberti* is a largely overlooked species from the Lake Edward drainage (Rutshuru river, Poll, 1939). Poll (op. cit.) reported the three syntypes to be in extremely poor condition and that scale counts were very difficult to obtain. The only scale count he gives, that of the lateral line, is higher than that recorded here for *Barbus stigmatopygus* (31 cf. 24–26) but Poll does not state where he terminated this count. I have not been able to examine the syntypes but the long barbels and general body shape are clear in fig. 9 of Poll (1939), the body spots less so. However, I consider these features to be sufficiently diagnostic to regard *Barbus alberti* as conspecific with *Barbus stigmatopygus*. The apparent differences between these nominal species are discussed below, following a redescription of *Barbus stigmatopygus*.

#### Redescription of *Barbus stigmatopygus*

A sample of 24 *Barbus stigmatopygus* covering the size range extending from the types of *Barbus wernerii* to the largest available specimens (i.e. 26–54 mm SL) forms the basis of this redescription. All proportional measurements are expressed as a percentage of the standard length.

**MORPHOMETRIC FEATURES.** Body depth  $\bar{x}$  = 31.3, range = 26.9–34.7; head length  $\bar{x}$  = 27.4, range = 25.5–34.7; eye diameter  $\bar{x}$  = 8.4, range = 6.9–10.4; caudal peduncle length  $\bar{x}$  = 20.8, range = 19.5–25.0; caudal peduncle depth  $\bar{x}$  = 14.1, range = 12.3–15.9; pectoral fin length  $\bar{x}$  = 19.7, range = 17.0–21.2; anterior barbel length  $\bar{x}$  = 8.4, range = 7.2–9.5; posterior barbel length  $\bar{x}$  = 11.6, range = 9.2–13.1.

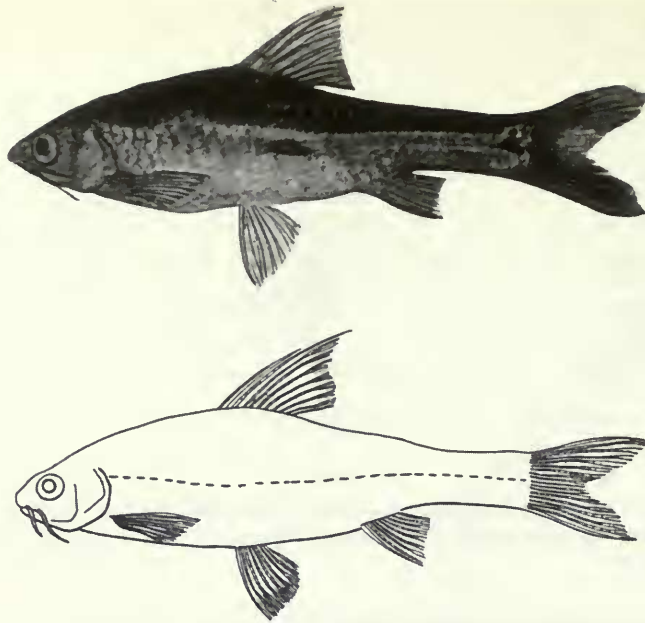


FIG. 9. — *Barbus alberti* sp. n. (riv. Rutshuru).  
Longueur : 95 mm.

Fig. 18 *Barbus alberti* from Poll, 1939. Original size.

The long barbels are particularly noteworthy. The posterior barbel extends to, or beyond, the angle of the preoperculum and the anterior one to, or beyond, a vertical through the middle of the eye (Fig. 9).

**FINS.** The dorsal fin has three unbranched and 7 (f4) or 8 (f20) branched rays. The anal fin has three unbranched and five branched rays (f24).

**SQUAMATION.** In the lateral line series there are 24 (f2), 25 (f8) or 26 (f14) scales. All the specimens examined have  $4\frac{1}{2}$  scale rows between the lateral line and, respectively, the dorsal and ventral mid-lines, and  $2\frac{1}{2}$  scale rows from the lateral line to the insertion of the pelvic fin. Twelve scales encircle the least circumference of the caudal peduncle. The scales have a few radiating striae and a clear focus (Fig. 19). The lateral line runs on the middle of the side of the caudal peduncle.

**GILL RAKERS.** In 12 specimens examined there are 2 (f1), 3 (f10) or 4 (f1) large gill rakers on the dorsal half of the first ceratobranchial; of these, the one or two nearest the epibranchial are larger than the rest. The lower half of the ceratobranchial is covered with a papillate tissue under which are 0 (f2), 1 (F2), 2 (f5) or 3 (f3) low ridges or protuberances of uncertain homology.

**PHARYNGEAL BONES AND TEETH.** A pharyngeal bone is shown in Fig. 21. The teeth are arranged in three rows of 2.3.5–5.3.2 teeth. The two teeth of the outer row are characteristically close together and not parallel to the middle row; rather, they, and the first tooth of the middle row appear to form a diagonal row. This, and the tooth form can be seen in Fig. 21.

**COLORATION.** Most specimens have three lateral spots, but some have up to five and others only two. Irrespective of the number of spots, a line of dark brown pigment is present and may join the middle and posterior spots, and sometimes joins all. The spots are usually just smaller than the scales. The first spot is at the overlap of the seventh and eighth scales of the row above the lateral line and the scale dorsally between them. The third spot, when present, is usually 6 or 7 scales caudad to the first spot and lies on, or in front of, the vertical from the base of the last dorsal fin ray.

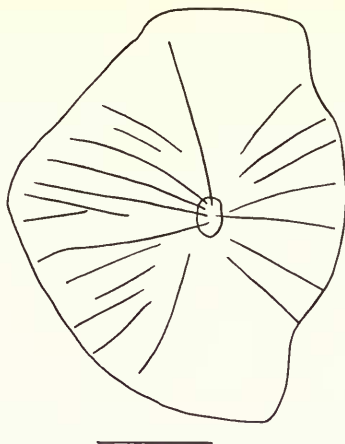


Fig. 19 A scale from the specimen shown in Fig. 9. Scale bar = 1 mm.

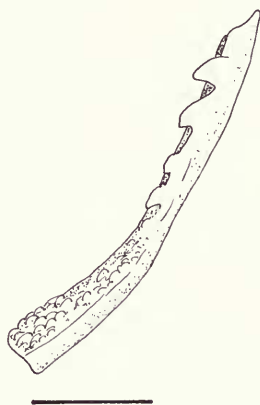


Fig. 20 The first ceratobranchial from a 50 mm SL specimen of the species shown in Fig. 9. Scale bar = 1 mm.

The fifth spot lies between the second and third pored-scales from the posterior end of the lateral line. The second and fourth spots are much smaller and correspond to the positions described for those in *Barbus weneri*.

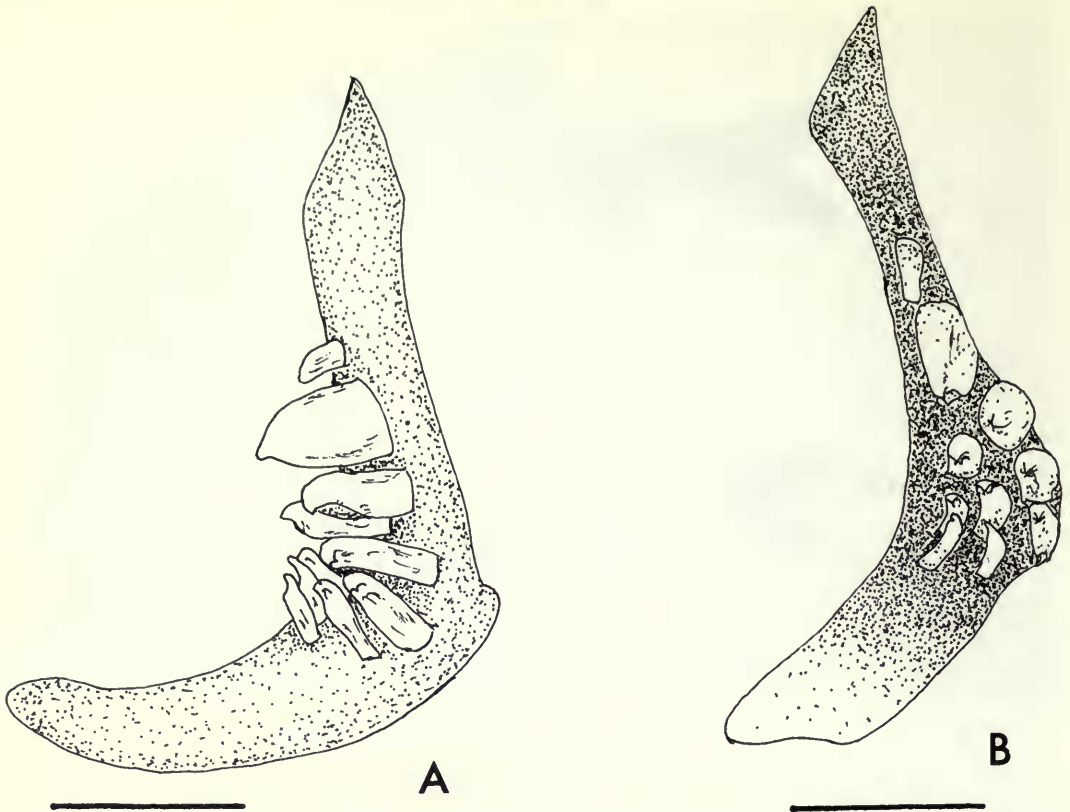
The body colour is yellow-brown to brown, darker on the back than on the ventral surface, with the pigment intensified on the posterior part of the exposed section of the dorsal scales. There is no silvery, reflective sheen as there is in *Barbus perince*.

### Discussion

The common possession of a few large gill rakers on the upper part of the first ceratobranchial, papillate tissue on the lower part, the alignment of the pharyngeal tooth rows and the position of the flank spots, appears to justify considering *Barbus stigmatopygus*, *Barbus weneri* and *Barbus alberti* as conspecific despite seeming contradictions in the colour pattern, the number of pored scales in the lateral line and the number of barbels. These apparent anomalies are discussed below.

#### (d) Comments on the pigmentation pattern

Hitherto, the main difference in pattern noted between *Barbus stigmatopygus* and *Barbus weneri* (see Boulenger, 1911) is the presence of a small black spot at the base of the anal fin in *Barbus*



**Fig. 21** A. The left pharyngeal bone of a 50 mm SL specimen of the species shown in Fig. 9. Scale bar = 1 mm. B. The same pharyngeal bone positioned to show the alignment of the tooth rows. Scale bar = 1 mm.

*stigmatopygus*. The pigment is only partly superficial. In small (juvenile) fishes the densest concentration of melanophores lies in the muscles at the base of the anal fin and is visible through the thin layer of translucent skin. With growth, the superficial melanophores disappear. Those in the anal fin muscles remain but become less dense and are no longer visible through the tissue.

Such deeper pigmentation in various young cyprinid fishes has been noted by Balinsky (1948) and Kortmulder & Van der Poll (1981). In a staged growth series of *Barbus stigmatopygus* from seasonal pools in the Sudd (1985.1.29: 64–83 and 84–98; 14–50 mm SL) the anal fin spot becomes faint at about 18–20 mm SL. It is not usually visible in fishes larger than 23 mm SL. However, the internal pigmentation is still present in specimens over 40 mm SL.

The anal fin spot has been shown to be a juvenile character in other cyprinid species e.g. *Barbus binotatus* Valenciennes 1842 (Weber & de Beaufort, 1916: 188).

The variation in pigmentation pattern, especially the anal fin spot, formerly used in distinguishing these species, is thus no more than an ontogenetic feature.

#### (e) The lateral line tubules

Little has been published on the development of the pores of lateral line scales. Scale formation frequently starts at the lateral line (Neave, 1940) but there is no information on whether the tubule forms concurrently with the growing scale or whether it is a later development.

Mori (1931a, 1931b) studied the formation of the lateral line tubule formation in transplanted scales on the goldfish (*Carassius auratus* (L.1758)). He found that in ordinary scales transplanted



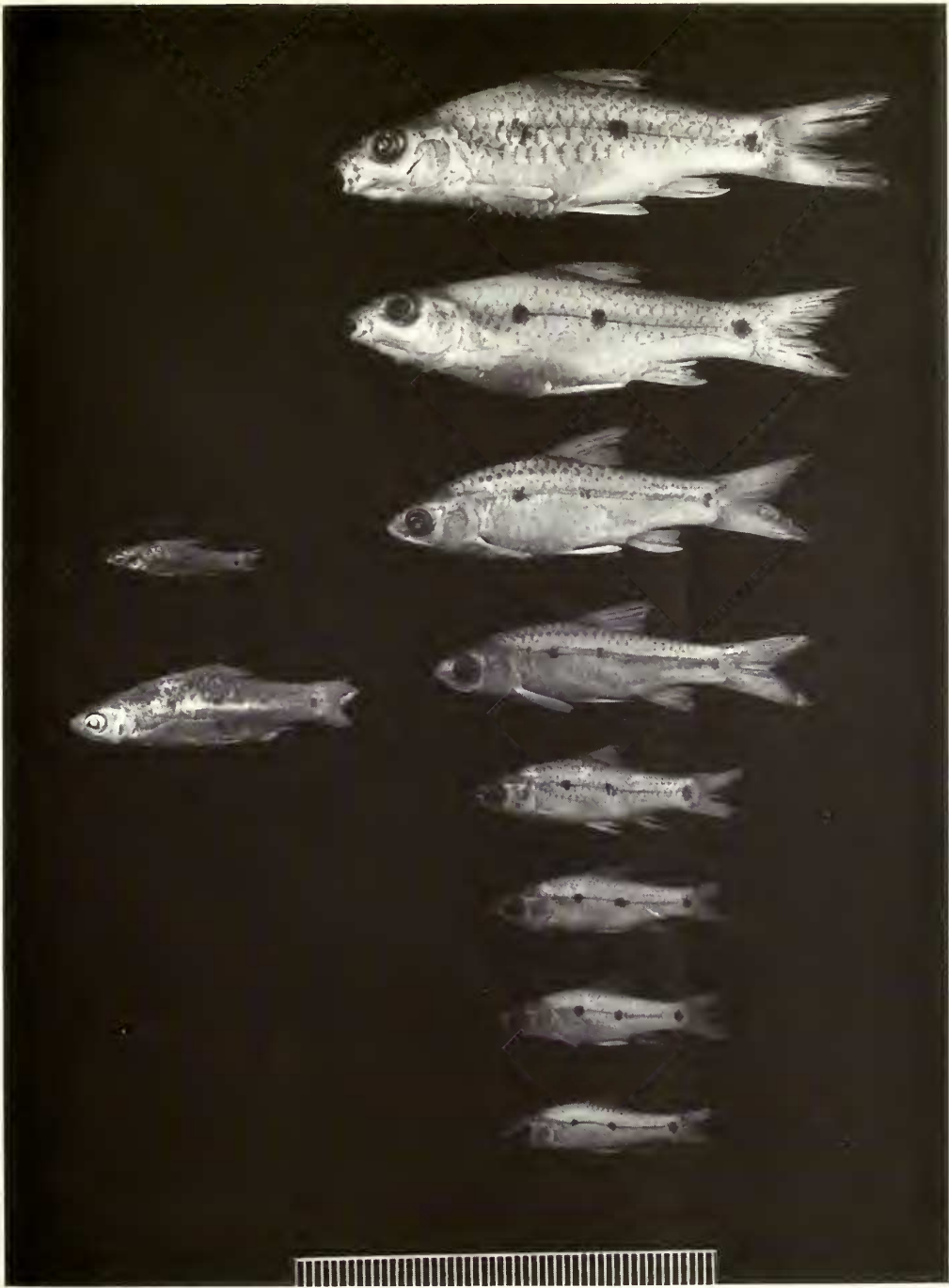


Fig. 22 Growth stages of *Barbus stigmatopygus*. A syntype is at the top left and a syntype of *Barbus weneri* below it.

into lateral line scale pockets from which the scales had been removed they only developed the pore after the canal from the preceding scale had grown backwards beneath the transplanted scale and the lateral line organ had developed. Whether this method of pore formation occurs in ontogeny is unknown.

In the east African species *Barbus neumayeri* (Fischer, 1884) scales become distinguishable in specimens between 10 and 20 mm SL, tubules are detectable in the better formed lateral line scales at less than 20 mm SL and a full complement is present at 22 mm SL (Banister, 1980). The smallest specimen of *Barbus stigmatopygus* available to me is 12 mm SL; it is fully scaled, but its poor condition precludes the detection of tubules in the lateral line scales. Specimens of 14 mm SL have 4, 5 or 6 scales with well defined tubules (as in the 15–20 mm SL syntypes). Specimens of more than 20 mm SL have pores in all the lateral line scales. The anterior few pored scales appear much earlier than the others, but, to judge by the small size differences between specimens with only the anterior set of pores and those with a full complement, the posterior pores develop extremely rapidly. The posterior pores first appear as a shallow groove in scales which continue the horizontal series of anterior tubule-bearing scales caudad. The groove runs from the middle of the scale to the posterior margin where the edge of the scale is notched. In two specimens (19.0 and 19.5 mm SL ex 1985.1.24: 84–98) there is no perforation in these scales. In the same lot there is a slightly larger fish (20.0 mm SL) in which the edges of the groove are raised, whilst in a fish of 20.5 mm SL the leading scales of the posterior row series have the groove roofed over, leaving a pore posteriorly. In a specimen of 23.5 mm SL only the last two lateral line scales are incompletely roofed over, a long posterior slit persisting. At 50 mm SL the only discernable differences between the anterior and posterior series of the lateral line tubules is that the former are slightly wider and the lateral wall of the tube is thicker.

#### The number of barbels

As now defined, *Barbus stigmatopygus* contains fishes with 0, 2 or 4 barbels. In the syntypic series, posterior barbels are detectable in 3 specimens longer than 19 mm SL. The smaller fishes are without barbels, although, as noted earlier, the likelihood of seeing them in such poorly preserved material is remote.

In specimens recently collected in the Sudd (1985.1.29: 64–83), the posterior barbel becomes visible as a small protuberance in fishes of about 14 mm SL. Thereafter, barbel growth is rapid (Fig. 23); in fishes of 16 mm SL, the posterior barbel is about 0.15 mm long, at 20 mm SL 1.2 mm long, and at 27 mm SL 2.1 mm long. The anterior barbel first appears at about 20 mm SL and its subsequent growth is also rapid. In adults the barbels are characteristically long (see p. 128).

In another sample from further north in Sudan (Tira Mandi, 10°54'N, 30°30'E and Umm Jan, 11°20'N, 30°31'E—both localities are included in 1948.1.14: 83–121, 10–34 mm SL) the posterior barbels appear at about 14 mm SL and the anterior ones at about 17 mm SL.

It has been argued (Banister, 1980) that too much reliance has been placed on the use of barbels in barbine classification. *Barbus stigmatopygus* is yet another reason why the Schultz (1957) classification of barbines into genera with, respectively, 4, 2, or 0 barbels is untenable.

In the case of *Barbus amboseli* Banister, 1980 which has a similarly delayed barbel development, I suggested that the number of barbels might be related to the sex of the fish as is the case in some populations of *Barbus anoplus* Weber, 1897 (Jubb, 1967). I can add nothing to the arguments for *B. amboseli* as no new specimens are available, but in *B. stigmatopygus* there is no link between barbel development and sex; the barbels simply develop later than in many other species, although earlier than in *B. amboseli* where the anterior barbels start to form at about 35 mm SL. The largest known specimen of *Barbus amboseli* is 45 mm SL *cf* 54 mm SL for *Barbus stigmatopygus*.

#### Redescription of *Barbus tongaensis* Rendahl, 1935

The collection made by Dr R. G. Bailey in the Sudd contained 40 specimens of this species which was previously known only from the holotype. An expanded description is therefore given below.

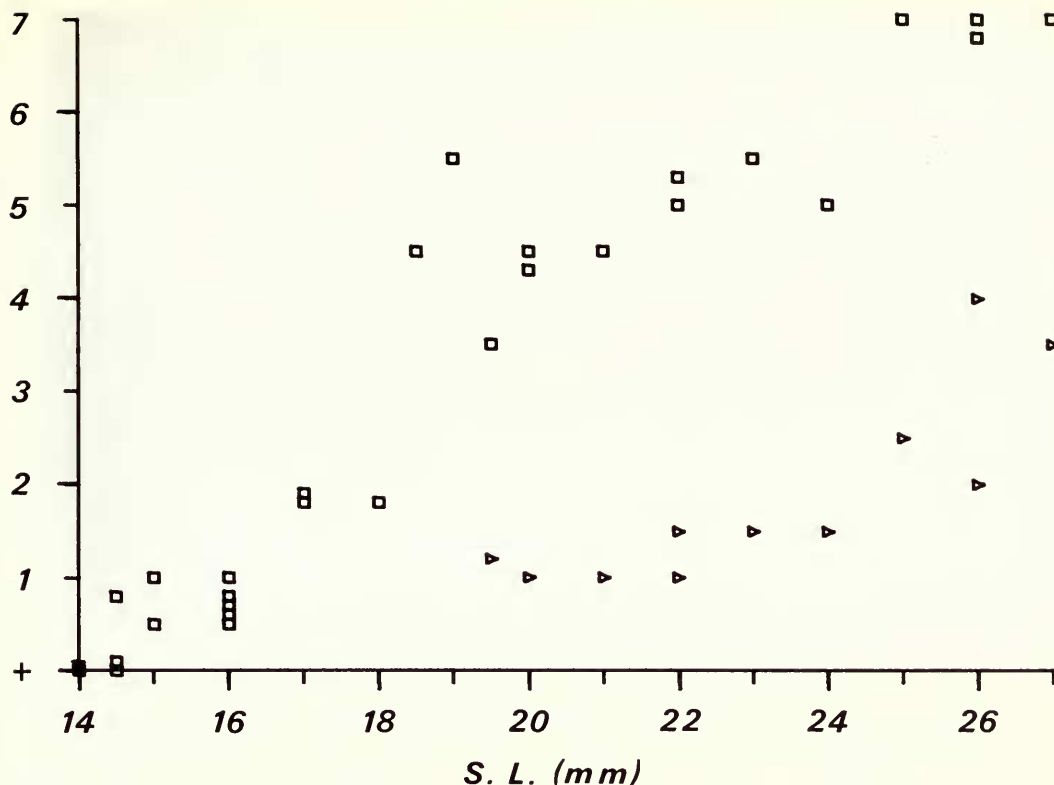


Fig. 23 Barbel growth in *Barbus stigmatopygus*.  $\triangleright$  = anterior barbel,  $\square$  = posterior barbel. The vertical axis is an arbitrary scale relating to the gradations on the eyepiece graticule.

*Barbus tongaensis* Rendahl, 1935 *Annls Zool. Soc. Vanamo* 2(2): 14. The holotype (99PIS in the Department of Zoology, Turku University (Finland) was caught at Tonga (9°22'N, 31°06'E) in Sudan. This recent sample came from seasonal pools from between Jalle and Kongor, about 250 kms from the type locality. The size range of the sample is 18.5–25.00 mm SL and it contains sexually mature males and females, the latter are conspicuously deeper bodied than the males (see Fig. 25).

**MORPHOMETRIC FEATURES.** The morphometric features of a sample of 10 fishes covering the size range of the sample (including the holotype, 25 mm SL—in parentheses) are given below.

Body depth  $\bar{x}$  = 30.9, range = 25.6–35.0; this very wide range reflects the depth of body of mature females ( $n$  = 4, range = 30.3–35.0); head length  $\bar{x}$  = 28.6, range = 23.6–31.0 (26.8); eye diameter  $\bar{x}$  = 8.5, range = 7.5–9.7 (8.0); interorbital width  $\bar{x}$  = 10.8, range = 9.3–12.6 (12.0); pectoral fin length  $\bar{x}$  = 19.6, range = 18.7–22.7 (19.6); caudal peduncle length  $\bar{x}$  = 20.3, range = 18.6–23.0 (20.6); caudal peduncle depth  $\bar{x}$  = 13.2, range = 12.1–14.6 (13.9); posterior barbel length  $\bar{x}$  = 4.8, range = 3.6–6.1 (6.1) (only the posterior barbel is present); last unbranched dorsal fin ray length  $\bar{x}$  = 26.7, range = 24.3–29.2 (broken in the holotype).

**FINS.** The dorsal fin has 3 unbranched (f10) and 7 (f2) or 8 (f8) branched rays. The anal fin has 3 unbranched and 5 branched rays (f10). The last unbranched dorsal fin ray is smooth, thin and flexible. All the fins are colourless.

**SQUAMATION.** The lateral line consists of only 3 (f3), 4 (f3), 5 (f3) or 6 (f1) perforated scales. The first one or two tubules lie within the mid-lateral pigment stripe but the rest follow a descending course below it.

The flank scales are deep (Fig. 26) and bear few radiating striae. The depth of the flank scales is reflected in the low number 8 (f10) of scales around the least circumference of the caudal peduncle.



Fig. 24 The holotype of *Barbus tongaensis*.

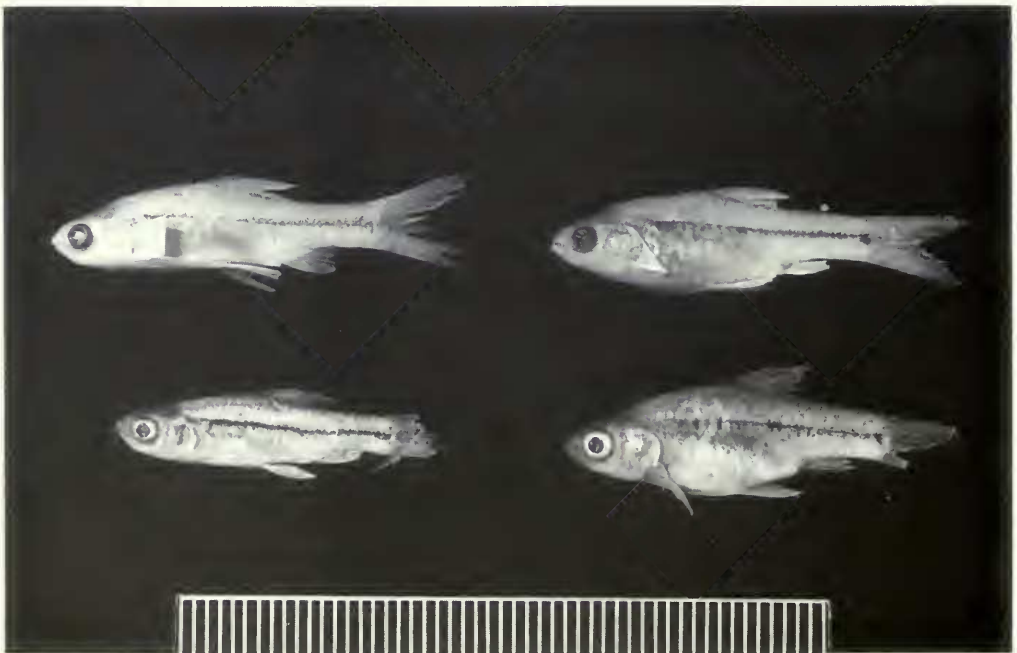


Fig. 25 *Barbus tongaensis*. Recently collected specimens to contrast the males (left) with the deeper bodied females.

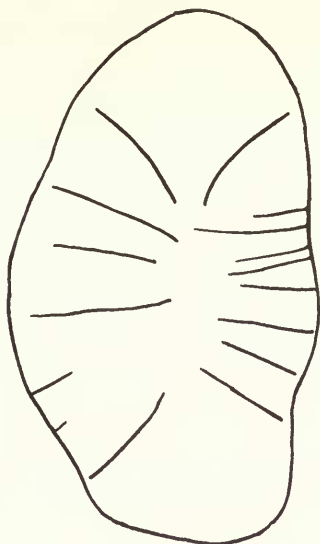


Fig. 26 A scale of *Barbus tongaensis*. Scale bar = 1 mm.

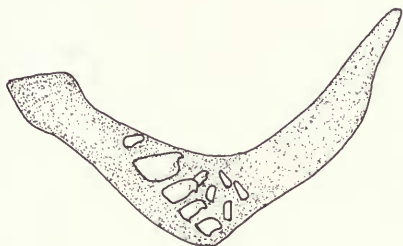


Fig. 27 A pharyngeal bone of *Barbus tongaensis*. Scale bar = 1 mm.

In the lateral line series there are 19 (f2), 20 (f4), 21 (f3) or 22 (f1) scales. Between the mid-dorsal line and the lateral line there are 4 (f10) scales and from there to the mid-ventral line there are 3 (f9) scales.

**PHARYNGEAL TEETH.** The pharyngeal teeth are arranged in three parallel rows of 2.3.5–5.3.2. (Fig. 27) and have hooked crowns.

**GILL RAKERS.** On the first ceratobranchial there are 5 (f4) or 6 (f5) short, dumpy gill rakers.

**COLORATION.** In alcohol preserved specimens the body colour is a pale yellow-brown. A dark narrow stripe runs from the top of the operculum to the end of the caudal peduncle. In smaller fish this mid-lateral stripe is expanded into a spot posteriorly. The stripe is not conspicuous in living fish (field observation by Dr R. G. Bailey). There is a faint brown median stripe in front of the dorsal fin. Only in smaller fishes is there a dark spot at the base of the anal fin.

### Distribution of Nilotic *Barbus* species reaching a small adult size

The distribution of these *Barbus* species is interesting. Only one, *Barbus tongaensis*, is endemic, and is confined to the Sudd region of the White Nile. Of the remaining nine species, three, *B. kerstenii* Peters, 1868, *B. neumayeri* Fischer, 1884 and *B. pellegrini* Poll, 1939, occur within the Nile drainage only in the Lake Albert–Edward region but are otherwise variously widespread within East Africa. *Barbus pellegrini* extends as far as Lake Tanganyika, whilst *Barbus neumayeri*, the most extensively distributed of the three occurs widely over Uganda, Kenya and Tanzania. The distribution of this species and the other two is given in detail in Daget *et al.*, 1984. However, I am unable to trace the *Barbus neumayeri* locality of Lake Basuto that they cite, and suggest that it may be a misprint for Lake Basotu, a small lake at 4°22'S, 35°05'E on the Singida Plateau, Tanzania.

In contrast, the six other Nilotic species are at the eastern edge of their range. *Barbus anema* Boulenger, 1903 is found from the White Nile to the Chad and Niger basins. *Barbus leonensis*



Fig. 28 The first ceratobranchial of *Barbus tongaensis*. Scale bar = 1 mm.

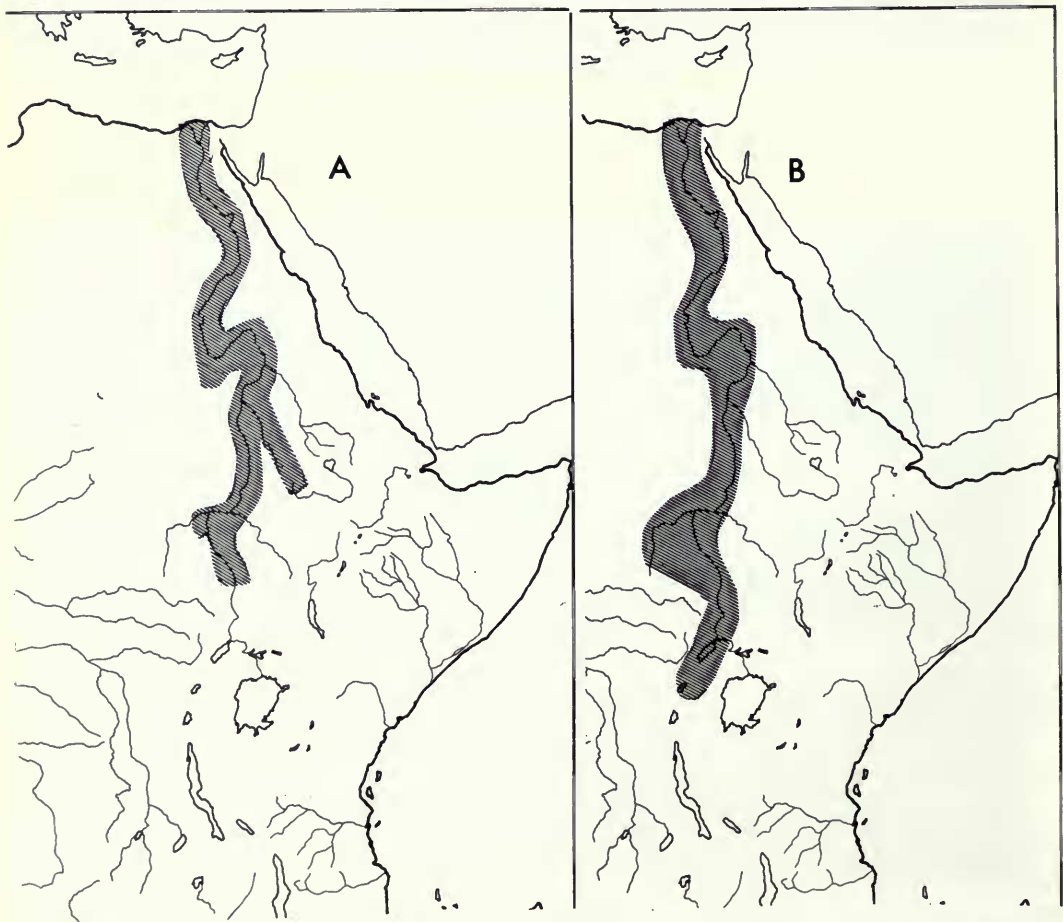


Fig. 29 The distribution within the Nile of (A) *Barbus perince*, (B) *Barbus stigmatopygus*.

Boulenger, 1915 occurs from the White Nile through the Chad, Niger and Volta systems to Gambia and Senegal. *Barbus perince* reportedly extends westwards as far as the Niger. *Barbus stigmatopygus* is found from the White Nile to the Volta. *Barbus yeiensis* Johnsen, 1926 and *B. pumilis* Boulenger, 1901 occur in the White Nile and Chad basins. Of these only the range of *Barbus perince* extends any distance up the Blue Nile (Fig. 29). The Blue Nile seemingly lacks small *Barbus* species except above the Tississiat Falls where there are species endemic to the Lake Tsana basin. However, in view of the inhospitability of much of the Blue Nile their absence is perhaps not surprising.

*Barbus* species, allegedly endemic to the Lake Victoria basin, do, however, occur in one Nilotic tributary. Greenwood (1963) noted the presence of the Nilotic species *Barbus perince* and *Barbus kerstenii* together with (*inter alia*) the Lake Victoria species *Barbus cercops* Whitehead, 1960 and *Barbus yongei* Whitehead, 1960 in the Aswa river, Uganda. The Aswa meets the Bahr-el-Jebel downstream of the Fola rapids and the town of Nimule in southern Sudan. Its headwaters are separated from the basins of Lakes Kyoga and Salisbury by a very low swampy divide. Greenwood (1963) suggested that the upper part of the Aswa river was formerly a part of the Victoria–Kyoga–Salisbury lake complex. Only a small tectonic movement would have been necessary to separate this arm of the lake and associate its drainage with that of the Nile. In view of the interesting faunal mixture in the Aswa river, it is unfortunate that the distribution of the various species within it is unknown.

### Summary

- (1) *Barbus neglectus* is a junior synonym of *Barbus perince*.
- (2) *Barbus alberti* and *Barbus weneri* are both junior synonyms of *Barbus stigmatopygus*.
- (3) When small (< c. 14 mm SL) *Barbus stigmatopygus* has no barbels and only the first few scales of the lateral line series have pores. At about 20 mm SL the lateral line is complete. Four characteristically long barbels are present in specimens over 30 mm SL.
- (4) When adult (> c. 25 mm SL) *Barbus stigmatopygus* can be distinguished from spotted specimens of *Barbus perince* by the presence of a few large gill rakers confined to the upper part of the first ceratobranchial, and by the position of the middle spot which is on, or in front of, the vertical from the base of the last dorsal fin ray.

### Key to the small *Barbus* species of the Nile (excluding Lakes Victoria and Tsana)

This key will only function when the fish have acquired most of their adult characters. Very small specimens are too similar to be keyed out. Delayed barbel development and lateral line tubule formation should be borne in mind.

1	Parallel striae on scales . . . . .	Juvenile large <i>Barbus</i> species
	Radiating striae on scales . . . . .	2
2	No barbels in fish > 16 mm SL . . . . .	3
	Barbels in fish < 16 mm SL . . . . .	5
3	Lateral line complete . . . . .	<i>Barbus anema</i>
	Lateral line incomplete . . . . .	4
4	Lateral line scales much deeper than long . . . . .	<i>Barbus pumilis</i>
	Lateral line scales about as deep as long, dark spot on dorsal fin . . . . .	<i>Barbus leonensis</i>
5	2 barbels in fish > 20 mm SL . . . . .	<i>Barbus tongaesis</i>
	4 barbels in fish > 20 mm SL . . . . .	6
6	First ceratobranchial with papillate tissue ventrally, few large gill rakers dorsally, flanks with up to 5 spots (NB juveniles have 0 or 2 barbels) . . . . .	<i>Barbus stigmatopygus</i>
	No such papillate tissue, gill rakers ventrally on first ceratobranchial . . . . .	7
7	Last unbranched dorsal fin ray smooth . . . . .	8
	Last unbranched dorsal fin ray serrated . . . . .	9
8	Body deep (> 30% SL at 35 mm SL), sometimes 3 spots on flanks, silvery . . . . .	<i>Barbus perince</i>
	Body shallow (< 25% SL at 35 mm SL), irregular longitudinal stripe . . . . .	<i>Barbus yeiensis</i>

9	No large spots or blotches on flanks . . . . .	<i>Barbus kerstenii</i> *
	Large spots or blotches on flanks . . . . .	10
10	Pelvic fin origin in advance of vertical from dorsal fin origin . . . . .	<i>Barbus pellegrini</i> *
	Pelvic fin origin more or less on the vertical from dorsal fin origin . . . . .	<i>Barbus neumayeri</i> *

\*within the Nile system limited to the Lakes Albert and Edward drainages.

### Acknowledgements

I am especially grateful to Dr Roland Bailey for so generously donating his collection from the Sudd to the BM(NH) and for giving me access to his field observations. My colleague Gordon Howes kindly drew Figures 3 and 9. Drs P. H. Greenwood and R. G. Bailey offered constructive advice on the manuscript.

### References

- Balinsky, B. I. 1948. On the development of specific characters in Cyprinid fishes. *Proceedings of the Zoological Society of London* **118**: 335–344.
- Banister, K. E. 1980. A new species of *Barbus* (Pisces, Cyprinidae) from Africa. *Bulletin of the British Museum (Natural History)* (Zoology) **38** (3): 145–150.
- Boulenger, G. A. 1903. Diagnoses of four new species of *Barbus* from the Nile. *Annals and Magazine of Natural History* (7) **12**: 532–533.
- 1905. On a second collection of fishes made by Mr S. L. Hinde in the Kenya district East Africa. *Proceedings of the Zoological Society of London* 1905 (1): 62–64.
- 1907. *Zoology of Egypt: the fishes of the Nile*. ii, 577 pp, 95 pls. Published for the Egyptian Govt. by Hugh Rees, London.
- 1911. *Catalogue of the freshwater fishes of Africa in the British Museum (Natural History)* Vol II, xii + 529 pp. 382 text figs. London.
- 1921. Liste des publications ichthyologiques et herpetologiques (1877–1920). *Annales de la Societe royale zoologique et malacologique de Belgique* **52**: 11–88.
- Daget, J., Gosse, J-P. & Thys van den Audenaerde, D. F. E. (Eds) 1984. *Checklist of the freshwater fishes of Africa*. Vol. 1, xviii + 410 pp. ORSTOM. Paris and MRAC Tervuren.
- Greenwood, P. H. 1963. A collection of fishes from the Aswa drainage system Uganda. *Proceedings of the Zoological Society of London* **140**(1): 61–74.
- Günther, A. C. 1868. *Catalogue of the fishes in the British Museum* **7**: 1–512.
- 1869. Appendix C. In: Pethrick, J. & B. H. *Travels in Central Africa and explorations of the Western Nile tributaries*, Vol. II.
- Jubb, R. A. 1967. *Freshwater fishes of southern Africa*. A. A. Balkema, Cape Town.
- Kortmulder, K. & van der Poll, R. J. 1981. The juvenile and adult pigment patterns of *Barbus lateristrigata* Cuv. & Val. 1842, *B. titteya* (Deraniyagala 1929) and *B. narayani* Hora 1937 (Pisces, Cyprinidae) and their taxonomic value. *Netherlands Journal of Zoology* **31** (2): 453–465.
- Mori, Y. 1931a. On the transformation of ordinary scales into lateral-line scales in the goldfish. *Journal of the Faculty of Science, Imperial University of Tokyo* (4) **2** (3): 185–194.
- 1931b. On the regeneration of the lateral line scales and lateral line organs in the goldfish. *Journal of the Faculty of Science, Imperial University of Tokyo* (4) **2** (3): 195–200.
- Neave, F. 1940. On the histology and regeneration of the teleost scale. *Quarterly Journal of Microscopical Science* **81**: 541–568.
- Poll, M. 1939. Poissons. *Exploration du Parc National Albert Mission G. F. de Witte* **24**: 1–82.
- Rendahl, H. 1935. Einige neue fische aus dem weissen Nil. *Annales Zoologici Societas Vanamo* **2** (2): 11–18.
- Rüppell, E. 1837. Neuer Nachtrag von Beschreibungen und Abbildungen neuer Fisch, im Nil Entdeckt. *Museum Senckenbergianum* **2**: 1–28.
- Sandon, H. 1950. An illustrated guide to the fishes of the Sudan. *Sudan Notes and Records*, 61 pp. McCorquodale & Co.
- Schultz, L. P. 1957. The generic names *Barbus* and *Puntius*. *Tropical Fish Hobbyist* **5**: 14–15, 29–31.
- Weber, M. & de Beaufort, L. F. 1916. *The Fishes of the Indo-Australian Archipelago* **3**. E. J. Brill. Leiden.